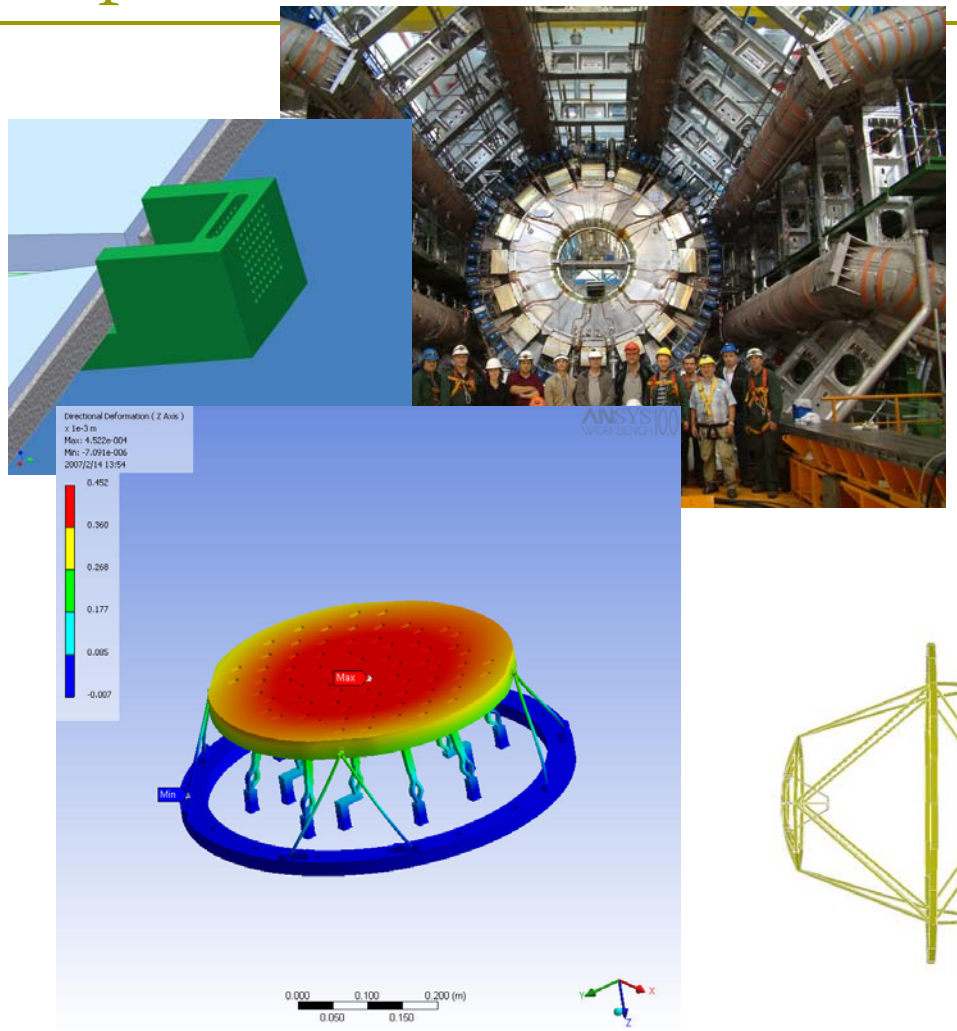
Mechanical Support Group
High Energy Physics Division
Argonne National Laboratory

Victor Guarino P.E.

Group Leader - Mechanical Engineer

Mechanical Support Group Capabilities

- Project Management
- Structural analysis
- Finite Element modeling
- 3D solid modeling and 2D drafting
- Mechanical construction
  - Fabrication
  - Fixturing
- Machine design
- Civil Construction
- Fiber optics
- Material testing
  - Creep testing
  - Bolt strength testing
- Automatic control systems
- Safety Analysis
- Hydraulics
- Ultra-High Vacuum
- Machine Shop Services



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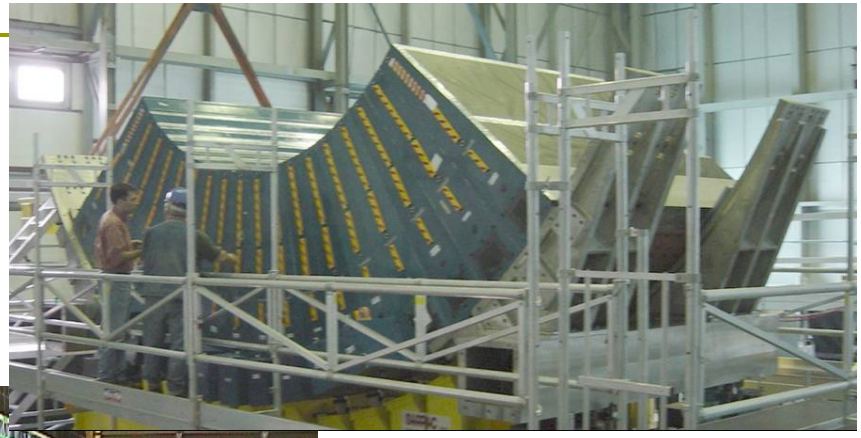
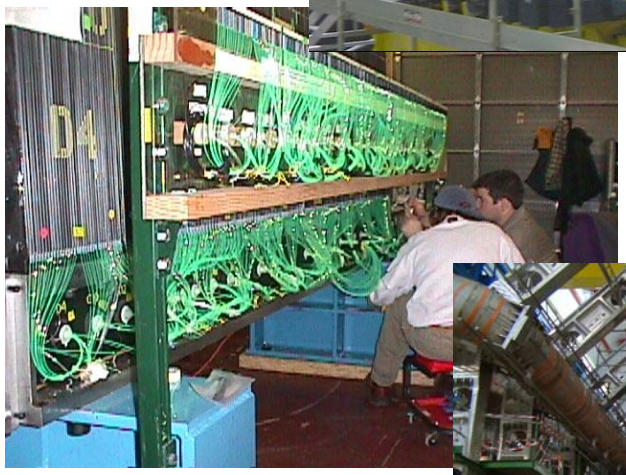
Current Experiments

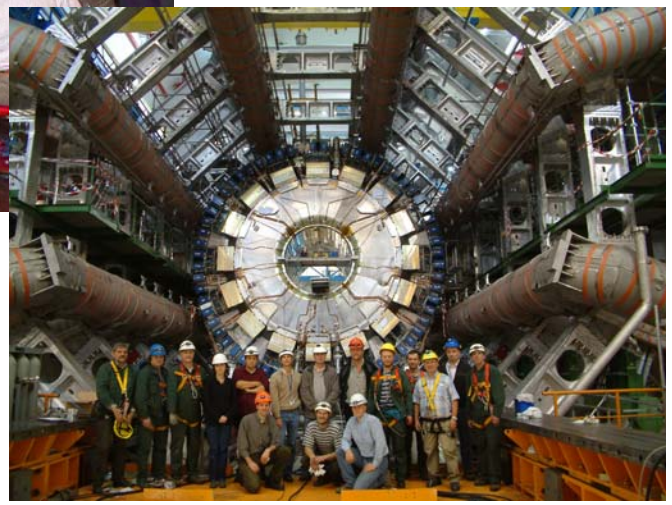
- **Tile Calorimeter in ATLAS at CERN**
- **ILC**
- **MINOS**
- **CDF Upgrade**
- **NOVA**
- **CHOOZ2**
- **Wakefield**
- **Auger**
- **Veritas**
- **DES**

Atlas

- Supervised the fabrication of raw steel plates. (80,000 5mm thick steel plates stamped in Czech Republic using US die)
- Supervised the fabrication of welded girder in Spain which acts as main structural support.
- Constructed 65 Extended Barrel modules.
- Instrumented 65 Extended Barrel modules
- Performed the complete structural analysis for ATLAS Tilecal
- Responsible for the design and implementation of the ATLAS moving system.
- Participating in support service installation
- Working with Technical Coordination on brackets and supports.







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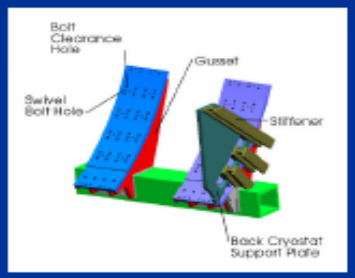
ATLAS Structural Analysis

ATLAS Tile Calorimeter Support Structure

High Energy Physics Division, Argonne National Laboratory

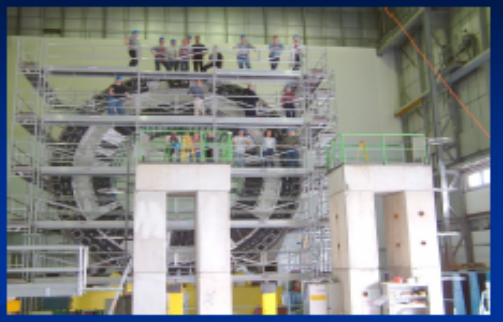
Pioneering Science and Technology

Argonne's High Energy Physics Division is collaborating on the LHC ATLAS experiment and was responsible for construction of a large fraction of the Extended Barrel Tile Hadron Calorimeter. HEPD is making a unique contribution to the experiment in terms of providing engineering design and analysis of much of the support structure of the calorimeter; the "saddles" on which the cylinders rest and the link plates which connect modules together. The resulting structure is entirely self-supporting .



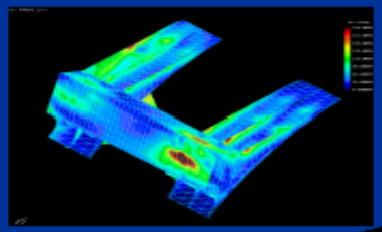
This schematic shows the main elements of the saddle. One pair of these is used to support each Extended Barrel cylinder, which is approximately 2.7m in length and 2 pairs of saddles are used to support the Barrel cylinder,which is 6m in length.

33mm diameter pins in the connecting plates between modules carry the tension load below the saddles which resists the moment from the modules above the saddles



A full pre-assembly of each cylinder will be carried out prior to final assembly in the ATLAS cavern.
The first of these is shown here. The assembled cylinder is itself over 8m high, weighs 640 tons and sits on 2 pairs of blocks below each of the saddle beams.

Modules in the region of the saddles simply rest on swivel bolts which are mounted in the holes shown.



Finite element analysis calculations were made for all connections in the structure. This figure shows the stress concentration in the saddles themselves. The stress concentration seen at the bottom of the beam results from the local load of the endcap calorimeter, which is itself supported from the tile calorimeter.

A special module for which the connecting plate is a single piece has a key which sits in the slots shown in the saddle. The key carries the vertical shear load in the cylinder which is transferred through the saddle to the ATLAS support rails..

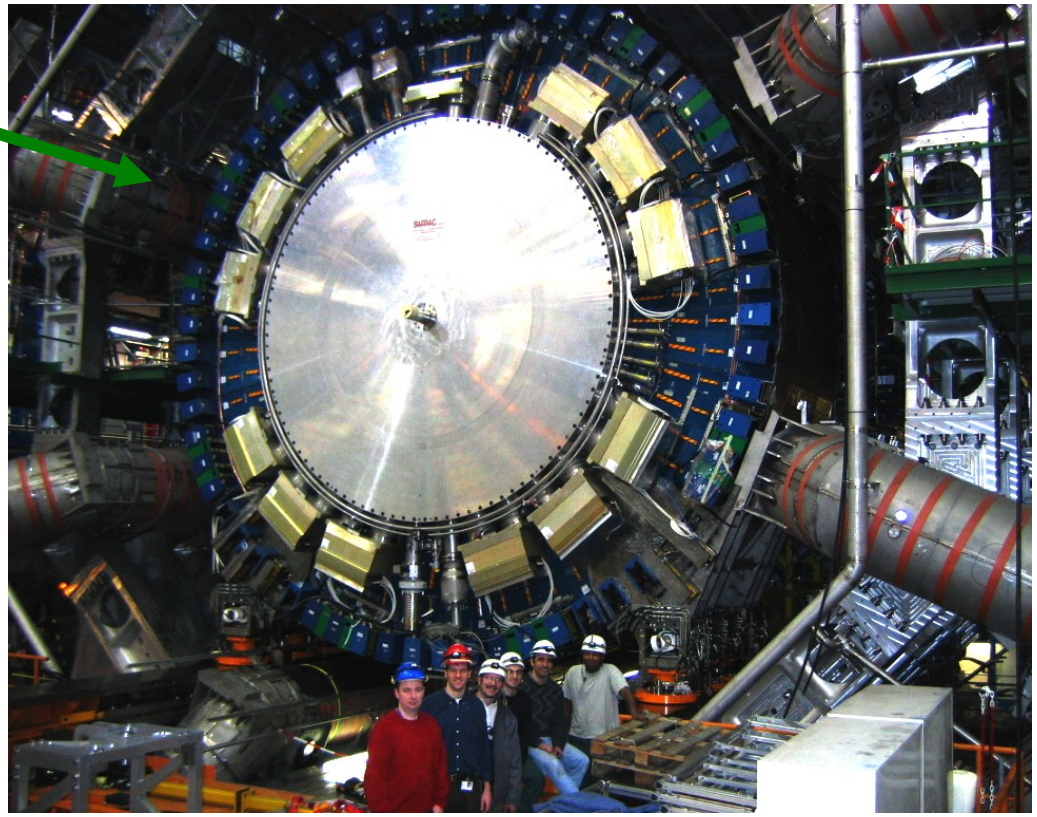
FURTHER INFORMATION: Argonne ATLAS Projects: gate.hep.anl.gov/lguo/atlas/atlas.htm
ATLAS Experiment: atlas.web.cern.ch/Atlas/Welcome.html

TileCal COLLABORATORS
Argonne National Laboratory plus institutions from Armenia, Brazil Belarus, Czech Republic, France, Greece, Italy, Portugal, Romania, Russia, Spain, Sweden, Slovak Republic, and the United States.

ATLAS Movement system fully functional and being used for EC Movements

April '06-'07

- System was used to close-up the End-Caps in preparation for the **magnet test** during the summer.
- The **automatic leveling system** was successfully tested during the EC movements and is complete.
- The guided service line and Liquid Argon Safety line interfaces were tested.
- Since August '06, the **CERN staff** has **independently** made several movements of End cap.



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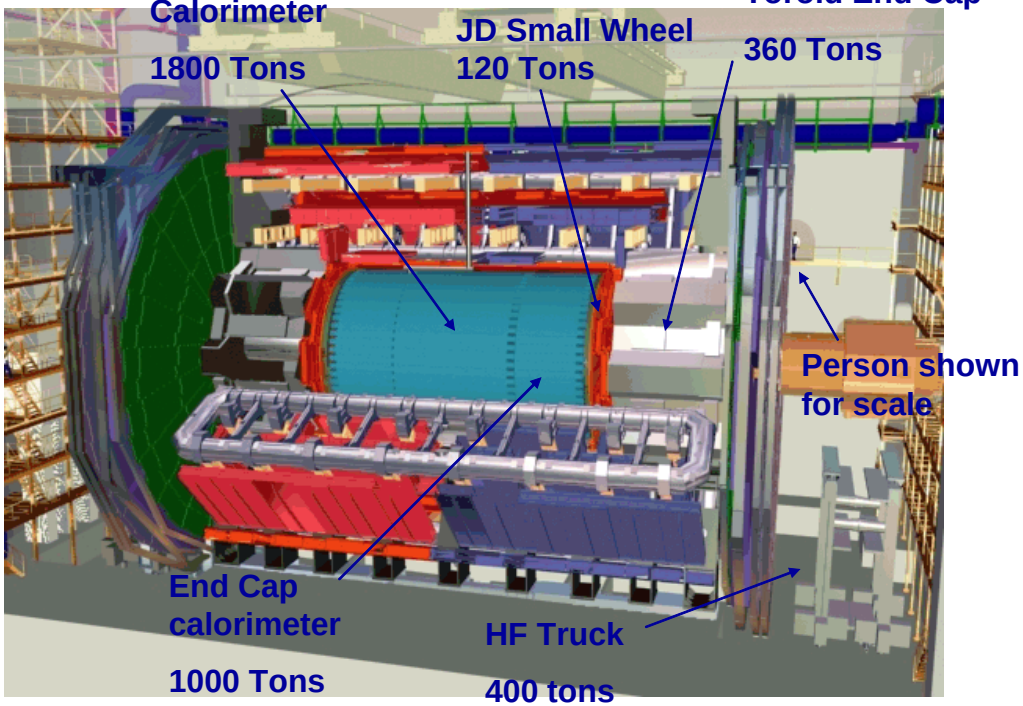
Expanding the Movement system for remaining detector systems

April - December '07

- Minor modifications needed to extend the system to move **JD** (small wheel), **Toroid End Cap**
- Additional hardware and logic to be added for **HF truck** movement with integrated gripping cylinder
- Integrate **Big Wheel** movement system into overall control system. Add tilt control of shielding



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MINOS

- Designed and fabricated the production equipment used to fabricate modules
  - Scintillator cutting station
  - Forming Station
  - Assembly trays
  - Module curing racks
  - Fiber gluing machine
  - Connector flycutter
  - Module Source Mapper
- Fabricated near detector modules
- Helped to design module components
- Performed R&D on Scintillator extrusions

Fiber Gluing Machine

- PLC controlled semi-automatic operation
- Applies epoxy, fiber, and tape in single operation
- Operator controls on both sides of carriage
- Accommodates 8 different type of module geometry
- Fiber and glue dispensing tracks scintillator groove

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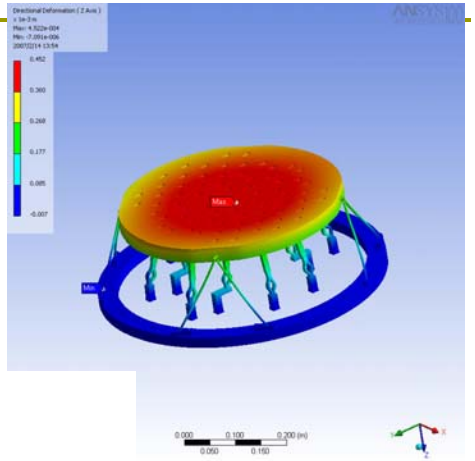
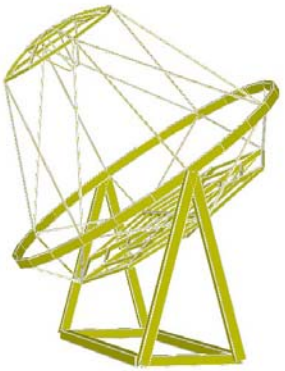
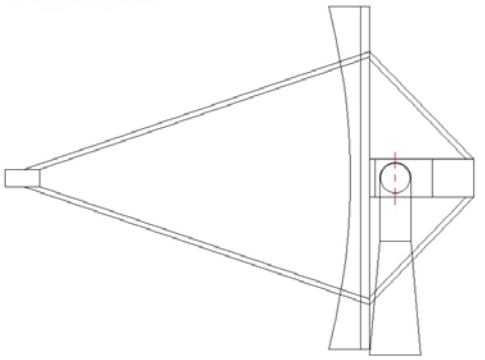
Astro-Experiments

- Performed extensive thermal and structural analysis on DES
- Collaborating with UCLA on developing conceptual designs for a 20m Veritas upgrade telescope.
- Collaborating with UCLA on a conceptual design for a new aplanatic two-mirror telescope.





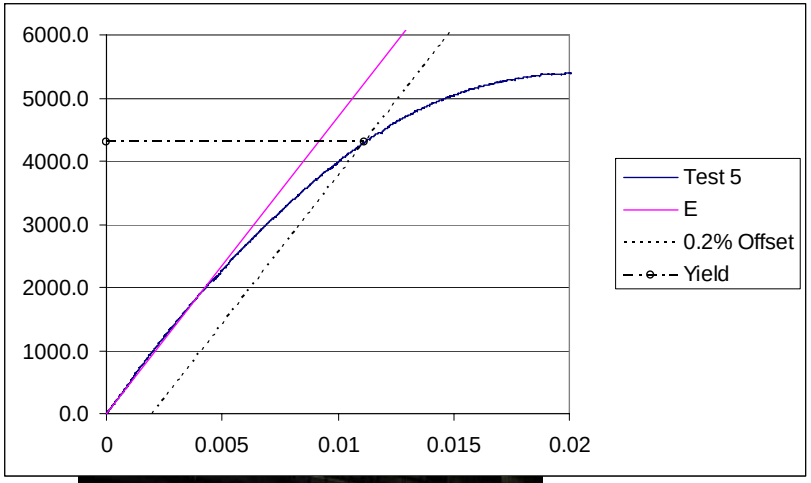


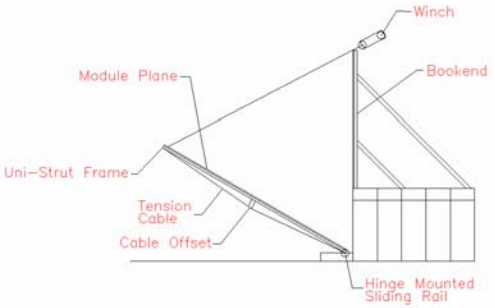
CDF Upgrade

- Designed and constructed CPR and CCR modules.
  - Optimized design for minimum deflection with maximum scintillator volume.
  - Developed fixturing and assembly techniques for efficient production
  - Mounting details
  - Tests of bond strengths, bond creep, module deflection
- Constructed 56 CPR modules, 56 CCR modules

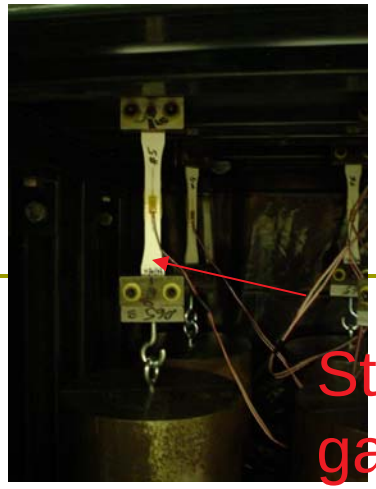
NOvA
PVC R&D

- Leading the R&D of PVC composition to optimize reflectivity and minimize creep.
- Conducting tests on materials
- Constructed a 27ft. x 15ft. Four plane prototoype to test construction methods.
- Conducting PVC and epoxy evaluations.

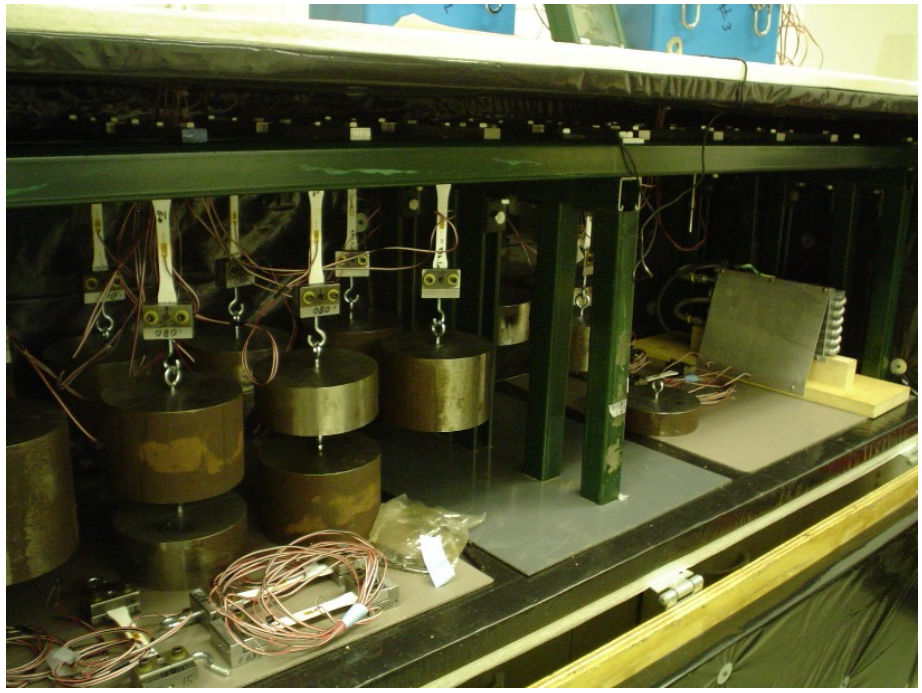




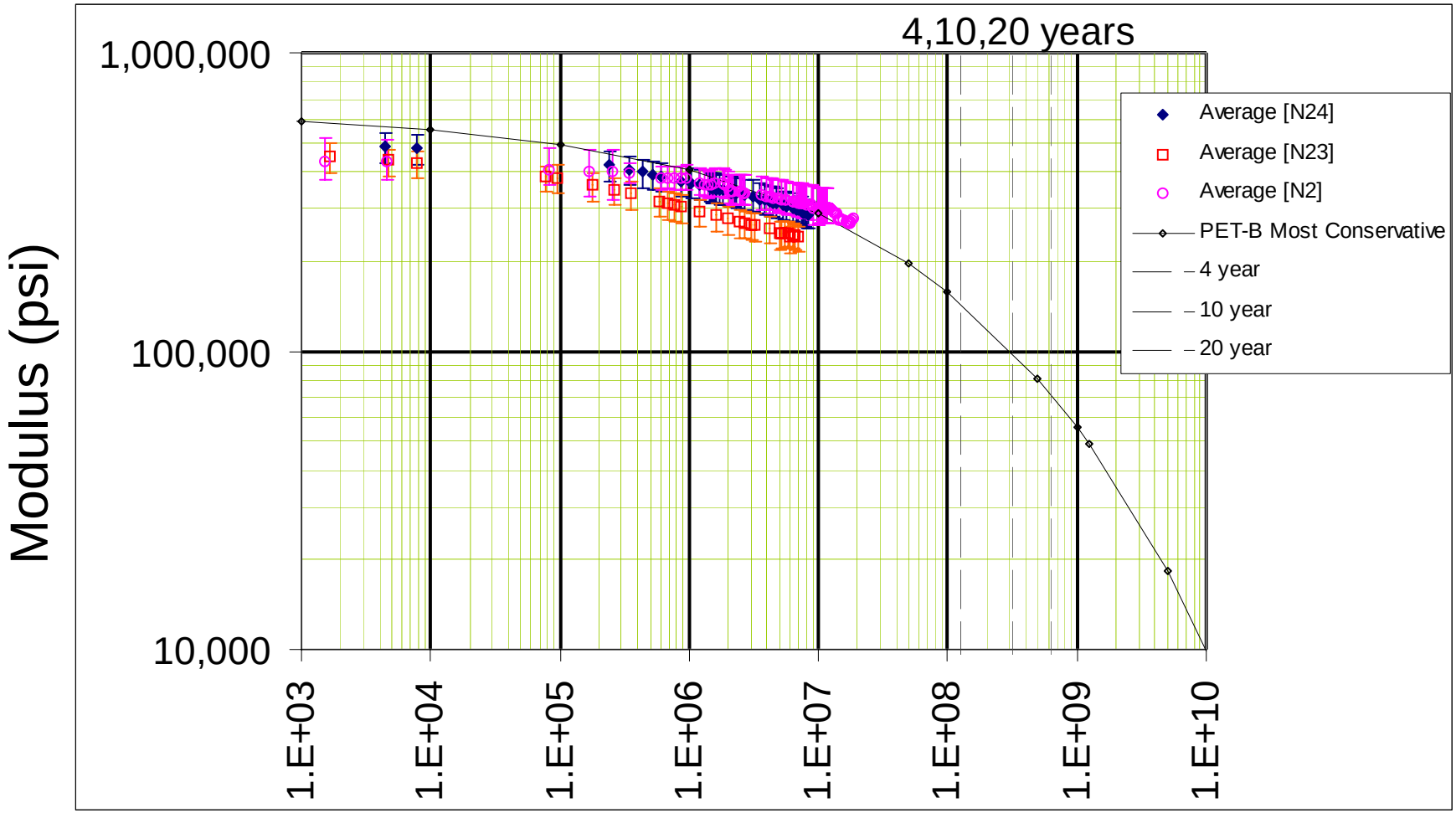
Long Term creep tests at ANL



- ASTM samples are instrumented with strain gages
  - Gages cancel bending
- Samples under test
  - **N2** - 6 samples – 213 days (2 each nominally at 300,500, 700 psi)
  - **N23** – 5 samples – 97 days (300 [1], 450 [2], 650 [2] psi)
  - **N24** - 5 samples – 80 days (300 [1], 500 [2], 700 [2] psi)
- Temperature controlled box constructed
  - Temperature is 20.4 +/- 0.3 ºC
  - Manual humidity control. Goal is 50% but excursions to 20% occur.
  - Unloaded control sample included and use humidity corrections

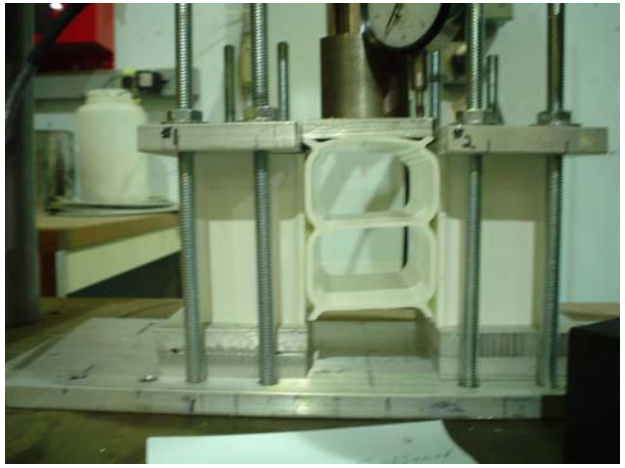


N2 (213 days), Nova 24 (97 days), N23 (80 days) compared to PET-B (most conservative) prediction



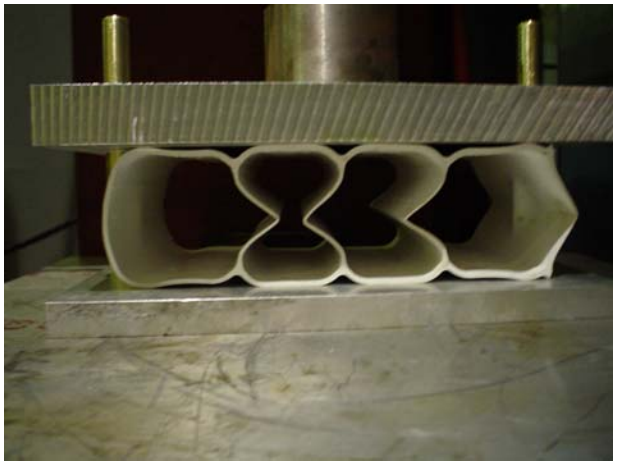
NOVA

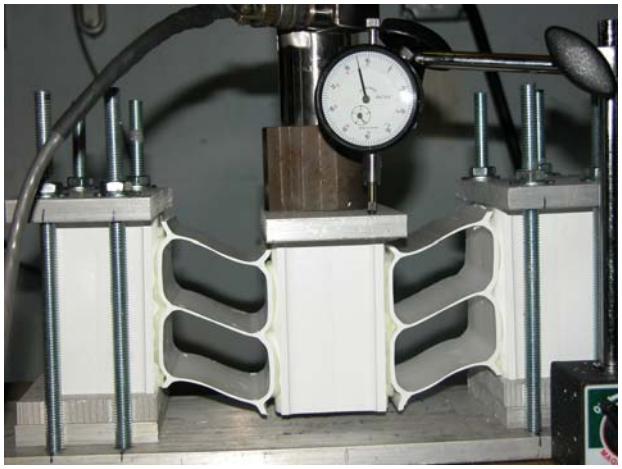
- Taking a leading role on the structural design, design and fabrication of assembly equipment, the evaluation of adhesive, and the development and evaluation of the required PVC.
- Responsible for the design of the IPND and its required fixturing and assembly tooling.
- Evaluating ES&H and designing a filtering system for handling VOC's from Adhesive



NOVA
Adhesive and Extrusion Testing

- Performing extensive evaluation of adhesive.
- Testing adhesive using standard ASTM tests as well as glued extrusions.
- Constructing prototypes small scale prototypes instrumented with strain gages to directly measure stresses and compare them to calculations.
- Worked with adhesive vendor to develop a custom adhesive.





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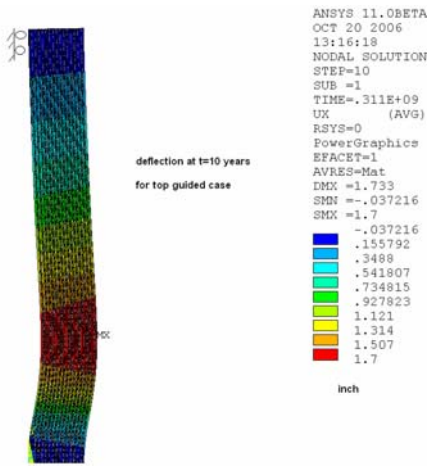
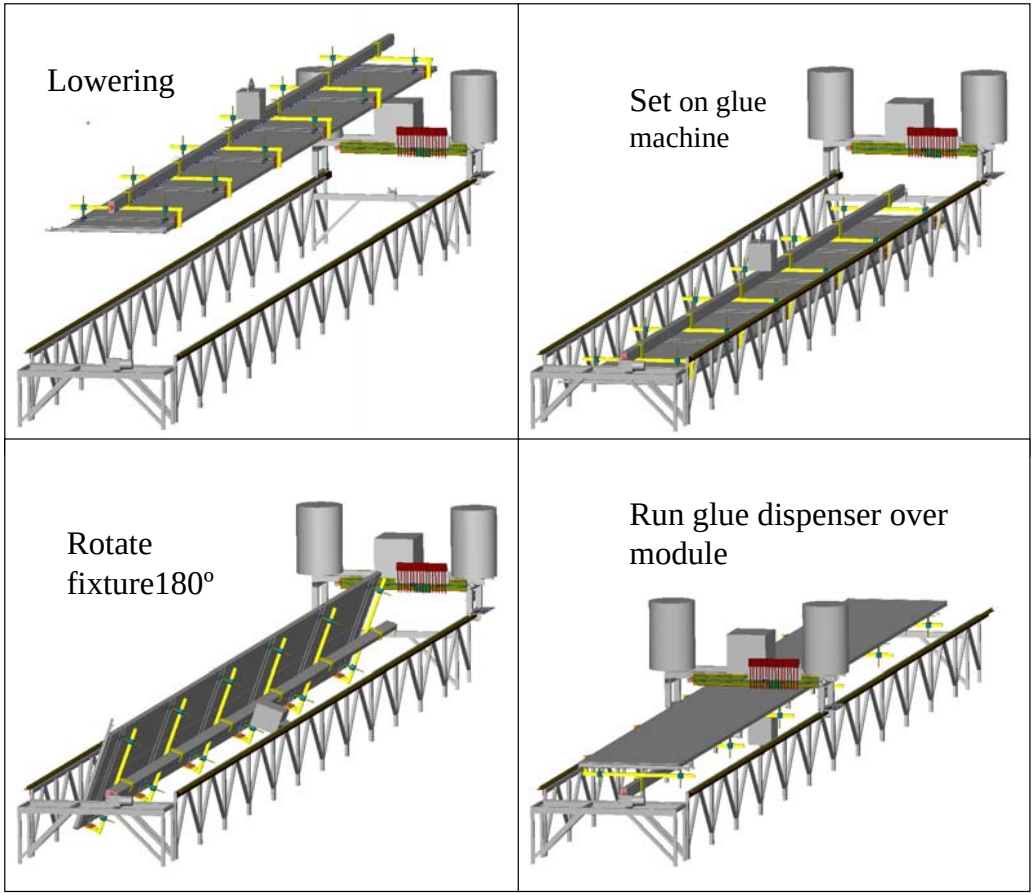
NOvA
Structural Analysis and Assembly

- L3 manager on structural analysis, assembly equipment and tooling, and adhesive R&D.
- Leading the design of the IPND
- Contributing to the Civil Engineering





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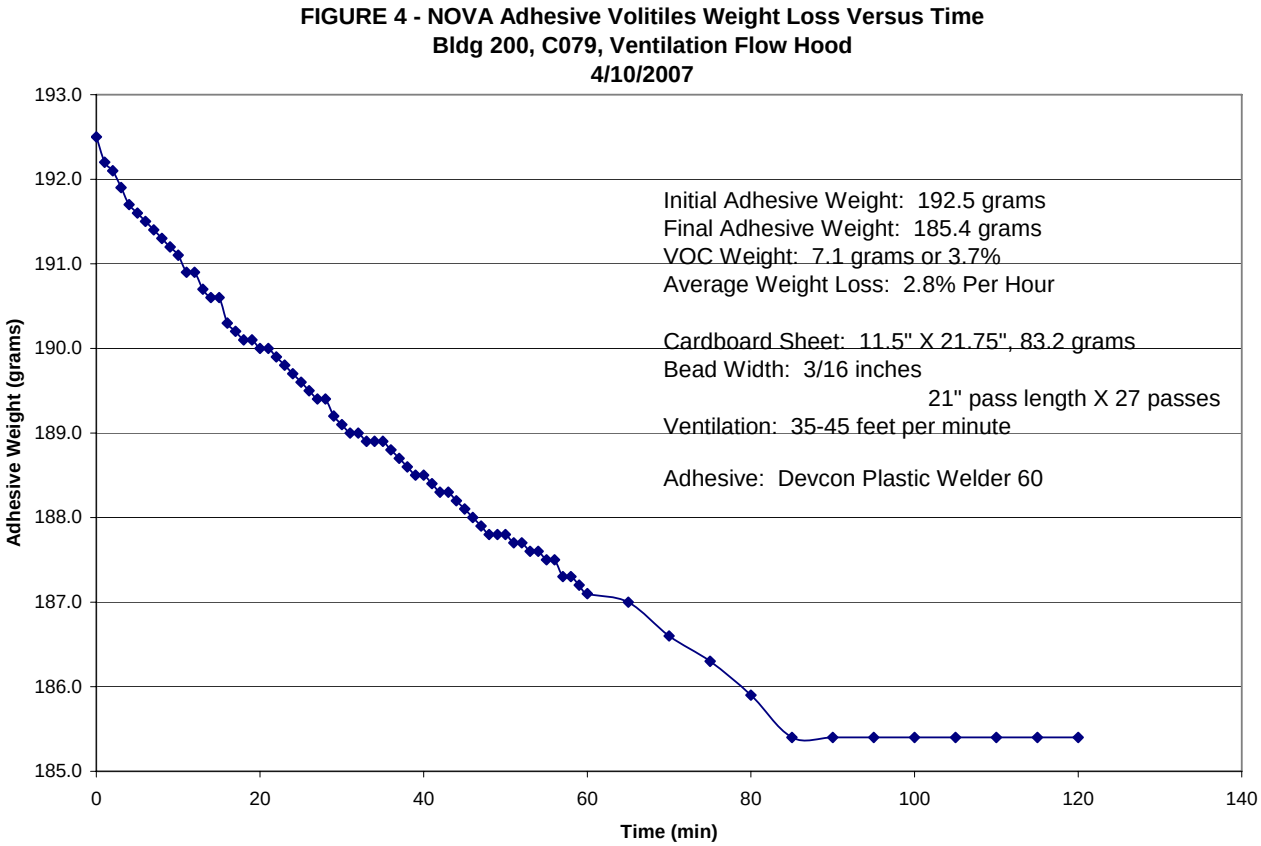
NOvA
ES&H

- Adhesive releases Methyl-Methacylate.
- Working with ANL Industrial Hygeine to monitor vapors during production.
- Working ANL IH to determine the generation rate of MMA in order to properly design a ventilation system.



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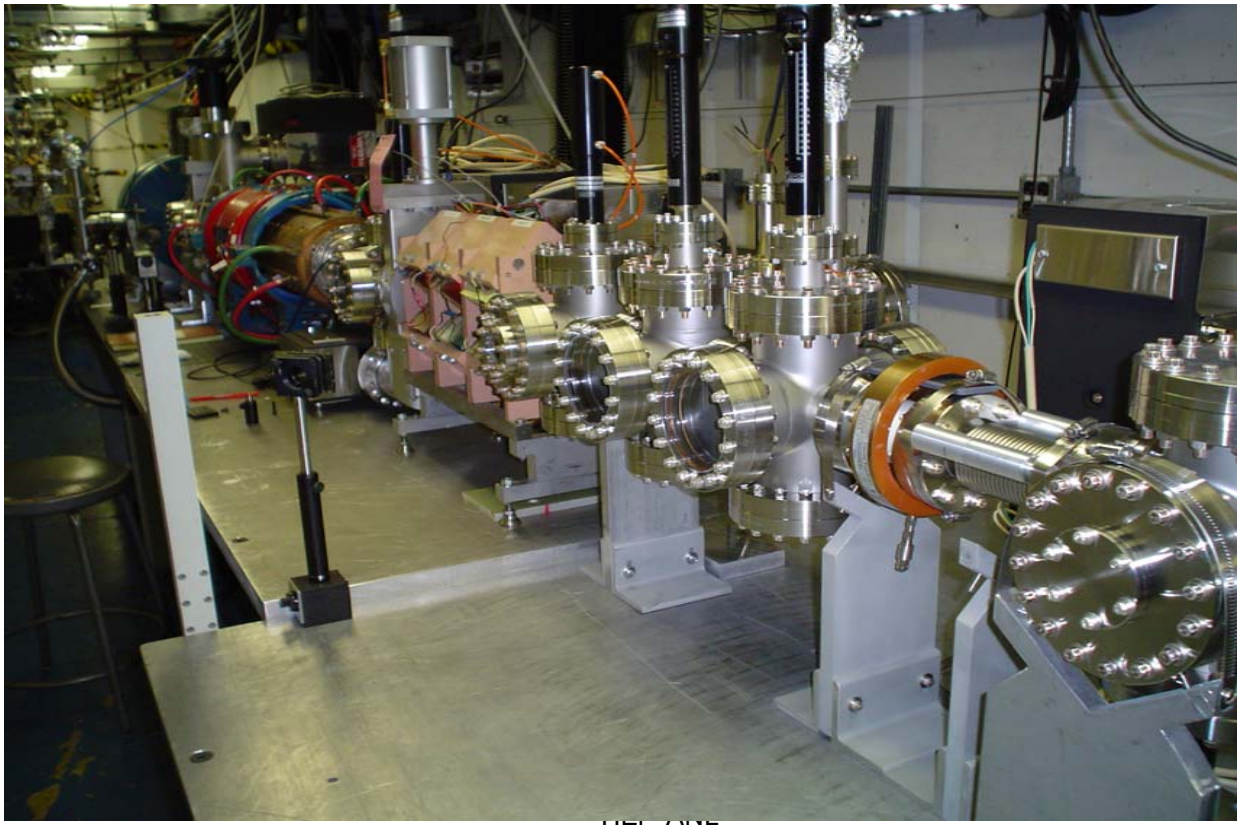
NOVA
Upcoming Work

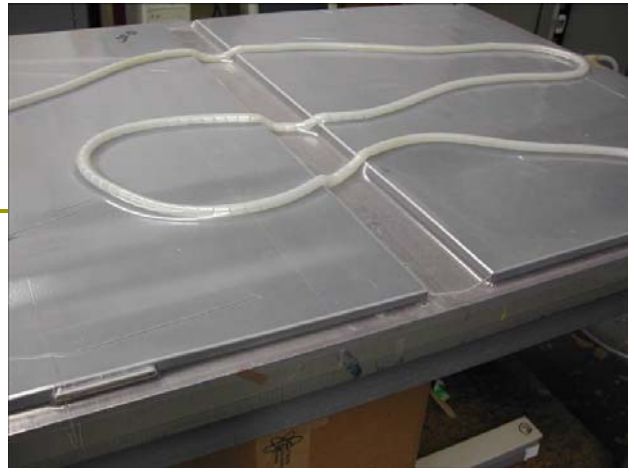
- A full size (53ft x 53ft) assembly prototype will be constructed at ANL.
- The IPND modules will be constructed at ANL.
- The full height prototype will be constructed at ANL and shipped to Fermi for installation and testing.

Wakefield

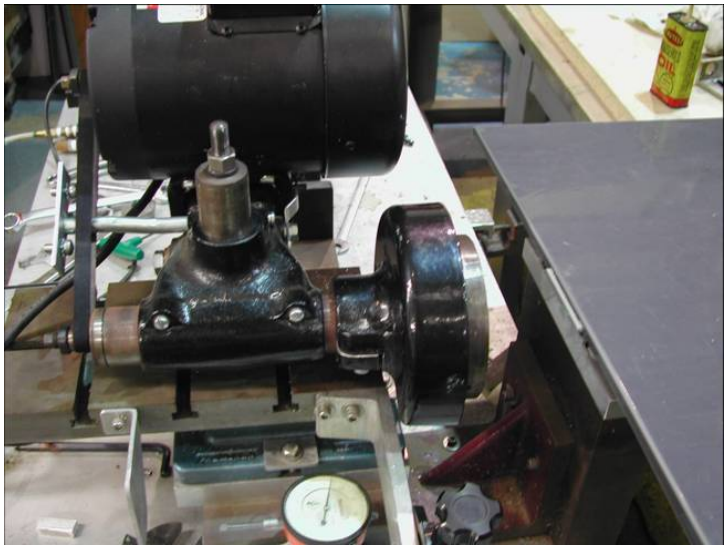
- Provide engineering services
- Technician support.

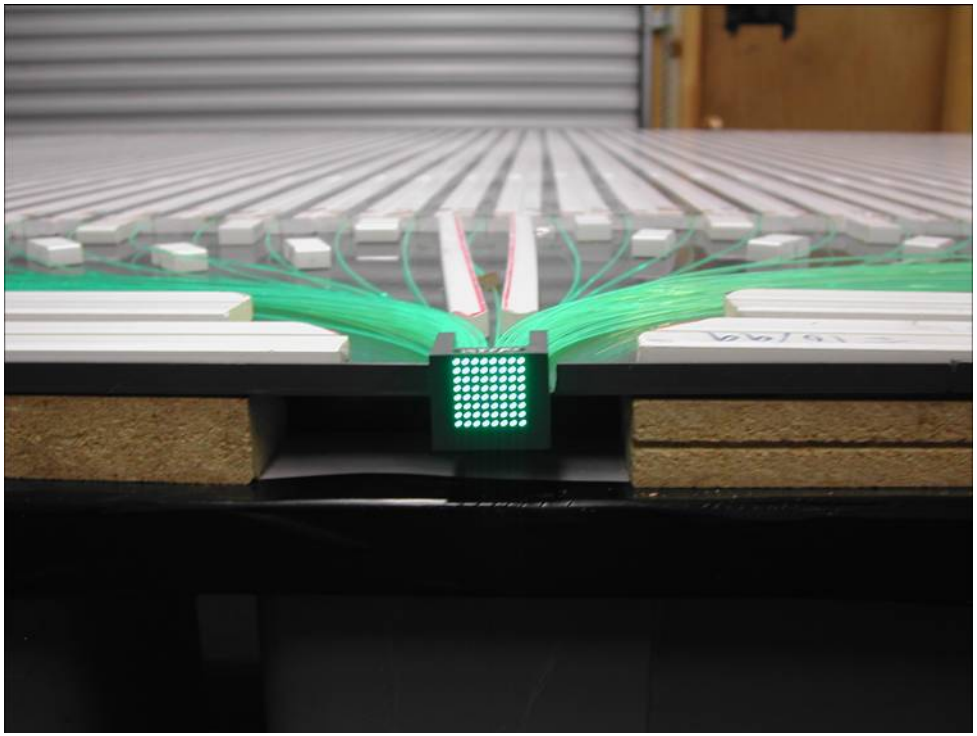


AUGER



- Developed design and fabricated prototype module.
- Designed and fabricated fiber cookie.
- Glued and routed fibers in scintillator strips.





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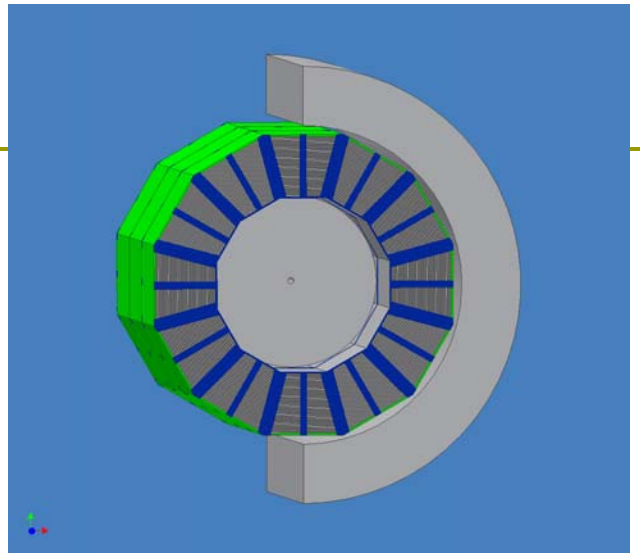
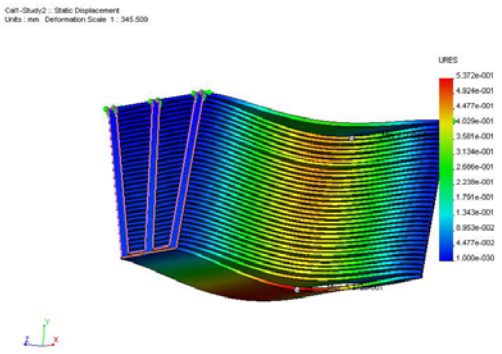
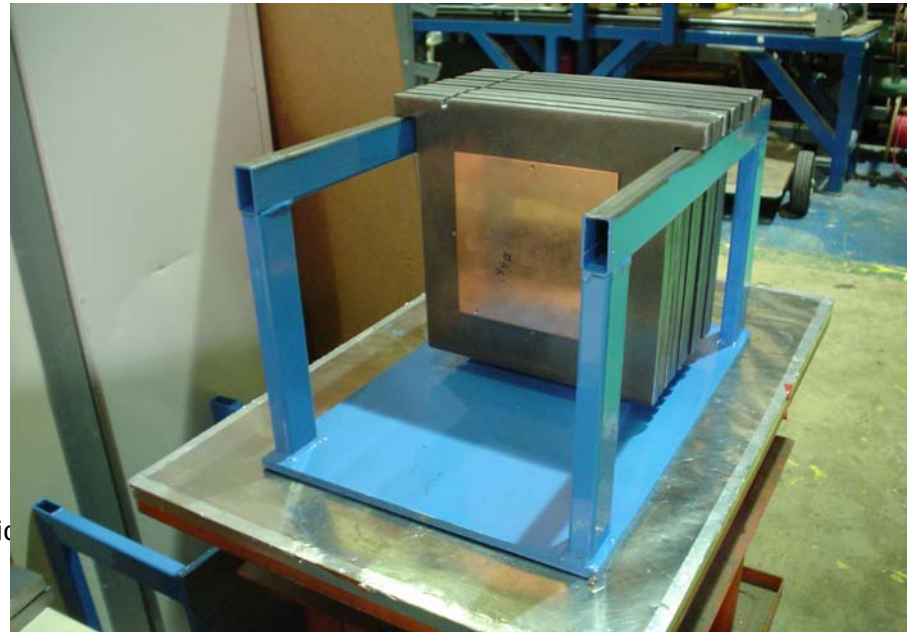
ILC



- Working on RPC design and method of fabrication.
- Constructing SLICE test and 1m^2 test
- Detector design.
- Civil construction





Machine Shop

- Full Service Machine Shop
- Prototype, fixture, part fabrication.

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Conclusion

- Mechanical engineering and construction are central to the success of any HEP experiment today.
- ANL is in a position to provide major mechanical engineering and construction of the larger components of an experiment to complement the work of university collaborators.
- The Mechanical Support group has a broad range of skills and capabilities needed by high energy physics.
- ANL Mechanical Support has been a central component of the success of ANL's past experiments and are at the center of much of the work of exploring and preparing for the next generation of experiments.